Original Research Article

Study of serum magnesium in type-2 diabetes mellitus in Government Dharmapuri Medical College

Kumudha P[1], Sasikala J[2*]

[1]Assosciate Professor, [2]Assistant Professor, Department of Physiology, Government Dhamapuri Medical College, Dhamapuri, Tamil Nadu.
Email:drsasikalagnanavel@gmail.com

Abstract

Background: Magnesium deficiency has been proposed as a novel factor implicated in the pathogenesis of diabetic complications. Hypomagnesemia can be both a consequence and a cause of diabetic complications. Hypomagnesemia is a common feature in patients with type 2 diabetes. Although diabetes can induce hypomagnesemia, magnesium deficiency has also been proposed as a risk factor for type 2 diabetes. Magnesium is a necessary cofactor for several enzymes that play an important role in glucose metabolism **Aim of The Study:** To Correlate the relationship between magnesium levels and diabetes and also note its association with the level of control of diabetes. **Materials and Methods:** Patients with Type 2 diabetes who were visiting the OPD of the Medicine Department in Dharmapuri medical college, in the year 2017-2018 were included in the study. A total of 50 cases of type-2 diabetes mellitus were taken for the study after satisfying the inclusion and exclusion criteria. 50 nondiabetic patients were taken as controls. All the patients were evaluated in detail and serum magnesium levels were estimated using the calmagite method. **Results:** The serum magnesium levels among cases and controls were 1.67±0.37 mg/dl and 2.03±0.25 mg/dl respectively. The serum magnesium levels were 1.75±0.34 mg/dl and 1.25±0.19 mg/dl respectively. **Conclusion:** There was a significant reduction in serum magnesium levels in diabetics compared to the controls. There was a significant correlation between magnesium levels and the level of control of diabetes. The levels of magnesium were found to be lower in uncontrolled diabetics.

Key Words: Type 2 Diabetes Mellitus; Magnesium, Peripheral Vascular Disease, Peripheral Neuropathy.

***Address for Correspondence:**
Dr. Kumudha P, Assistant Professor, Department of Physiology, Government Dhamapuri Medical College, Dhamapuri, Tamil Nadu, INDIA
Email:drsasikalagnanavel@gmail.com
Received Date: 10/05/2019 Revised Date: 02/06/2019 Accepted Date: 26/07/2019
DOI: https://doi.org/10.26611/1031122

Access this article online

Quick Response Code:

Website: www.medpulse.in

Accessed Date: 01 August 2019

INTRODUCTION

The prevalence of diabetes is on the rise. Besides multiplying the risks of coronary heart disease, diabetes enhances the incidence of cerebrovascular strokes.[1] Moreover, it is the leading cause of acquired blindness and accounts for over 25 percent of cases with end-stage renal failure as well as 50 percent of nontraumatic lower-limb amputations.[2] Hypomagnesemia is a common feature in patients with type 2 diabetes. Although diabetes can induce hypomagnesemia, magnesium deficiency has also been proposed as a risk factor for type 2 diabetes.[3] Magnesium is a necessary cofactor for several enzymes that play an important role in glucose metabolism. Animal studies have shown that magnesium deficiency has a negative effect on the post-receptor signaling of insulin. on the post-receptor signaling of insulin. Some short-term metabolic studies suggest that magnesium supplementation has a beneficial effect on insulin action and glucose metabolism. [4] Hypomagnesemia has long been known to be associated with diabetes mellitus. Low serum magnesium level has been reported in children with insulin-dependent diabetes mellitus and through the entire spectrum of adult type1 and type2 diabetes mellitus regardless of the type of therapy. Initially, the cause of

How to cite this article: Kumudha P, Sasikala J. Study of serum magnesium in type-2 diabetes mellitus in Government Dharmapuri Medical College. *MedPulse International Journal of Physiology*. August 2019; 11(2): 25-29. https://www.medpulse.in/Physiology/

hypomagnesemia was attributed to (1) osmotic renal losses from glycosuria (2) decreased intestinal magnesium absorption and redistribution of magnesium from plasma into red blood cells caused by insulin effect. Recently a specific tubular magnesium defect in diabetes has been postulated.[5] Hypermagnesemia results specifically from a reduction in tubular absorption of magnesium. Magnesium is involved in multiple levels in insulin secretion, bindin, and activity. Cellular magnesium deficiency can alter of the membrane-bound sodium-potassium- adenosine triphosphatase which is involved in the maintenance of gradients of sodium and potassium and in glucose transport. [6] In diabetics there is a direct relationship between serum magnesium level and cellular glucose disposal that is independent of insulin secretion. This change in glucose disposal has been shown to be related to increased sensitivity of the tissues to insulin in the presence of adequate magnesium levels. [7]Magnesium deficiency has been found to be associated with diabetic microvascular disease. Low serum magnesium level correlated positively with the velocity of regaining basal vascular tone after hyperemia.[8] Hypomagnesemia has been demonstrated in patients with diabetic retinopathy, with lower magnesium levels predicting a greater risk of severe diabetic retinopathy. Magnesium depletion has been associated with multiple cardiovascular implications: arrhythmogenesis, vasospasm, and hypertension and platelet activity.[9]

MATERIALS AND METHODS

Patients with Type 2 diabetes who were visiting the OPD of the Medicine Department in Dharmapuri medical college, in the year 2017-2018 were included in the study. A total of 50 cases of type-2 diabetes mellitus were taken for the study after satisfying the inclusion and exclusion criteria. 50 nondiabetic patients were taken as controls.

Inclusion criteria for case selection

Urine sugar-positive, Fasting blood sugar >126 mg/dl

Exclusion criteria for case selection

Patients excluded from this study were those diabetics who had associated hypertension, gastrointestinal disorders, impaired renal function, alcoholism pancreatitis, other endocrinal disorders and those on diuretic therapy, aminoglycosides, and iatrogenic administration. Those patients who had persistent FBS levels >126 mg% in spite of therapy during hospital stay were grouped as uncontrolled diabetics.

Inclusion criteria for controls

Age and sex-matched nondiabetic patients admitted in the hospital were taken as controls after applying the same exclusion criteria which were applied for the cases.

METHOD OF ESTIMATION OF SERUM MAGNESIUM

Under alkaline conditions, magnesium ions react with calmagite to produce a red complex which is measured spectrophotometrically at 530 nm. The intensity of the color produced is directly proportional to magnesium concentration in the serum. To eliminate the interference of calcium during estimation, EGTA is included in the reagent. Heavy metal interference is prevented by the presence of cyanide and a surfactant system is included to remove protein interference.

Statistical Methods

Chi-square and Fisher Exact test has been used to find the significance of the proportion of serum magnesium levels between cases and controls. Student t-test has been used to find the significance of the mean pattern of serum magnesium between cases/controls, Insulin/OHA and Controlled/Uncontrolled. Statistical software: The Statistical software namely SPSS 11.0 and Systat 8.0 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, table, etc.

RESULTS

Table 1: age distribution

Age in years	Cases		Controls	
	Number	%	Number	%
40	2	4.0	3	6.0
41-50	21	42.0	20	40.0
51-60	12	24.0	13	26.0
61-70	5	10.0	4	8.0
71-80	10	20.0	9	18.0
>80	-	-	1	2.0
Total	50	100.0	50	100.0
Mean ± SD	55.42±12.65		55.58±12.84	

Table: 1 shows The mean age of the diabetics was 55.42±12.65 years whereas it was 55.58±12.84 years respectively. Both among the cases and controls the sex distribution was same i.e. 62% and 38% males and females respectively. The maximum number of patients was in the age group of 41-50 i.e. 42%.

Table 2: mean pattern of FBS and S. Creatinine

FBS/S.Creatinine (Mean ± SD)	Cases	Controls	P value
FBS (mg/dl)	230.10 ±88.48	99.42±10.32	P<0.001
Serum Creatinine (mg/dl)	0.87±0.35	0.93±0.16	0.342

Table: 2 shows There was no significant difference between cases and controls with respect to serum creatinine levels. The mean serum creatinine levels among cases and controls were 0.87mg/dl and 0.93 mg/dl respectively. The mean FBS levels among cases and controls were 230.1 mg/dl and 99.42 mg/dl respectively.

Table 3: comparison of serum magnesium levels between cases and controls

Serum Magnesium	Cases (n=50)		Controls (n=50)	
	Number	%	Number	%
<1.0	1	2.0	-	-
1.0-1.50	19	38.0	1	2.0
1.50-2.00	21	42.0	31	62.0
2.00-2.50	9	18.0	16	32.0
>2.50	-	-	2	4.0
Inference	Cases are 32.066 times significantly more likely to have less Serum magnesium (<1.50 mg/dl) when compared to Controls with P<0.001			

Table :3 shows There is a significant difference between levels of serum magnesium levels among diabetics and controls. The mean serum magnesium levels in cases and controls are 1.67 mg/dl and 2.03 mg/dl respectively. Cases are 32 times more likely to have less serum magnesium (<1.50mg/dl) when compared to controls with p<0.001.

Table 4: effect Of Level of Control Of Dm On Serum Magnesium

Serum Magnesium	Controlled (n=34)	Not-Controlled (n=16)
Range (Min-Max)	1.20-2.50	1.00-1.60
Mean ±SD	1.75±0.34	1.25±0.19
95% CI	1.64-1.85	1.09-1.40
Significance	Student t=3.956, P<0.001	

Table: 4 shows There was a significant difference between magnesium levels among controlled and uncontrolled diabetics. The mean serum magnesium levels among controlled and uncontrolled diabetics were 1.75 mg/dl and 1.25 mg/dl respectively.

Table 5: effect of type of treatment on serum magnesium

Serum Magnesium	Insulin (n=34)	OHA (n=16)
Range (Min-Max)	1.0-2.20	1.60-2.50
Mean ± SD	1.50±0.27	2.02±0.29
95% CI	1.41-1.60	1.86-2.18
Significance	Student t=5.988, P<0.001	

Table: 5 shows Of the total of 50 diabetic patients 25(50%) were on insulin alone, 16(32%) were on OHA'S and 9(18%) were on a combination of OHA'S and insulin. The mean serum magnesium levels in the OHA group, insulin group and the insulin+ OHA group were 2.02 mg/dl,1.59mg/dl and 1.25 mg/dl respectively. The serum magnesium levels were significantly lower in the insulin-treated group compared to the OHA treated group.

DISCUSSION

The present study had diabetic patients ranging from 38-80 years. The average age of controls in the present study was 55.6 years while in the study of Liedtke RJ *et al* was 46.5 years. [10] The commonest in the present study was for various infections which accounted for 27% of patients. Infections included respiratory tract infections, meningitis, and acute cholecystitis. The next commonest cause for admission was a cardiovascular disease which accounted for 16% of the admissions.[11] Of this 50 % were on insulin, 37.5% on OHA's and 12.5% on OHA's and insulin both. [12] Of the cardiovascular disease 3 patients were admitted for stable angina, 3 for unstable angina and 2 for myocardial infarction. Neurological problems accounted for 12% of admissions. 4 patients admitted for stroke, 1 for cranial nerve palsy and 1 for peripheral neuropathy Peripheral vascular disease accounted for 12% of admissions. 4 patients had ischemic signs in the limbs and 2 patients had gangrene.6% of patients were admitted exclusively for poorly controlled diabetes. [13]The

reason for the increased number of patients (68%) being treated with insulin could be attributed to the fact that a good number of patients were admitted for various infections. In the diabetic group low serum, normal erythrocyte and high urinary magnesium levels were recorded in comparison to controls (2.03±0.25 v/s 2.07±0.27 in controls and 1.67±0.37 v/s 1.8±0.22 in diabetics). On establishing the relationship between magnesium levels and the state of control of diabetes, it was observed that in poorly controlled diabetic's serum and urinary magnesium levels were respectively lower and higher than that of poorly controlled[14] The present study compared similar parameters that was done by Rodriguez MM et.al evaluated intracellular (erythrocytic) Mg2+ concentration in 20 type 2 diabetics. In addition, the effects of intravenous 3-h drip or 8 weeks of oral magnesium supplementation on intracellular Mg2+ concentration levels and platelet reactivity was studied.[15]The results showed intracellular Mg2+ concentration of diabetic patients was significantly reduced compared with values in nondiabetic control subjects. Oral magnesium supplementation for 8 weeks (400mg/day) restored RBC magnesium concentration to normal without significantly changing serum magnesium concentration. Both intravenous and oral magnesium supplementation markedly reduced platelet reactivity in response to the thromboxane A2 analog, U46619.[16] Ryan MF et.al studied the interrelationships between hypertension, ischemic heart disease, and diabetes mellitus and diabetes mellitus in the diabetic subjects without ischemic heart disease or with ischemic heart disease and subjects with ischemic heart disease which were not complicated with diabetes mellitus.[17]. These results suggested that magnesium-deficient state is one of the causes of insulin resistance. The present study did not evaluate the interrelations between hypertension, ischemic heart disease. However, the magnesium levels of diabetics as compared to controls and the comparison of serum magnesium levels between well-controlled and poorly controlled diabetics had a positive correlation with the present study.[18] Savory J et.al in his study speculated on a potential link between magnesium deficit of diabetes and several diabetic complications including cardiovascular problems and retinopathy. However, in the present study, the complications of diabetes in relation to hypomagnesemia were not studied. This study focuses on estimating magnesium levels in type 2 diabetics at a given point (during admission) but not on therapeutically correcting hypomagnesemia or otherwise (not correcting) in the future course of the disease and its outcome.[19,20]

CONCLUSION

Serum magnesium levels were lower in type 2 diabetic patients when compared to controls. Levels of serum magnesium in uncontrolled type 2 diabetic patients were further lower than those in whom diabetes was under control. Hypomagnesemia is a factor in type 2 diabetes mellitus patients leading to various complications. Hence it is worthwhile estimating magnesium levels in type 2 diabetes mellitus patients and probably correlates their relationship with various complications.

REFERENCES

1. Altura BT, Dell OK, Yeh Q, *et al*. A new ion-selective electrode for ionized magnesium in whole blood, plasma, and serum. Clin Chem 1991; 37;948.
2. Alvin CP. Harrison's Principles of Internal Medicine.16th Edition. McGraw-Hill;2005.
3. Barbour HM, Davidson W. Studies on the measurement of plasma magnesium: Application of magon dye method to the monarch centrifugal analyzer. Clin Chem 1988; 34:2103-2105.
4. Burcar PJ, Boyle AJ, Mosher RE. Spectrometric determination of magnesium in blood using magon. Clin Chem 1964; 10:1028-1038.
5. David BM. Tietz textbook of clinical chemistry.2nd edition.W.B.Saunders; 1994.
6. Djurhuus MS, Gram J, Peterson PH, Klitgaard NA, Bollerslev J, Beck NH. Insulin increases renal magnesium depletion: a possible cause of magnesium depletion in hyperinsulinemic states. Diabet Med 1995; 12: 664-669.
7. Elin RJ. Status of mononuclear blood cell magnesium assay. J Am Coll Nutr 1987; 6:1965-1975.
8. Hatwal A, Gujral AS, Bhatia RP, Agarwal JK, Bajpai HS. Association of hypomagnesemia with diabetic retinopathy. Acta Ophthalmol 1989; 67:714-716.
9. Huerta MG, Holmes V F, Roemenich J N, *et al*. Magnesium deficiency is associated with insulin resistance in obese children. Diabetes Care 2005; 28: 1175-1181.
10. Liedtke RJ, Kroon G. Automated calmagite complexometric measurement of magnesium in serum with the sequential addition of EGTA to eliminate endogenous interference. Clin Chem 1984;30: 1801-1804.
11. Mastin MT, Shapiro R. Atomic absorption spectrometry of magnesium. Methods Enzymol 1988; 158: 365-370.
12. Paolisso G, Passariello N, Pizza G, *et al*. Dietary magnesium replacements improve B- cell response to glucose and arginine in elderly non-insulin dependent diabetic subjects. Acta endocrinol 1989; 121:16-20.
13. Paolisso G, Scheen A,D' Onfrio F, Lefebvre P. Magnesium and glucose. Diabetologia 1990; 33: 511-514.
14. Riduara RL, Stamfer MJ, Willet WC, *et al*. Magnesium intake and risk of type 2 diabetes mellitus in men and women. Diabetes Care 2004; 27:134-140.
15. Rodriguez MM, Guerero FR. Oral magnesium supplementation improves insulin sensitivity and metabolic control in type 2 diabetic subjects. Diabetes Care 2003; 26: 1147-1152.

16. Rude RK, Singer FR. Magnesium deficiency and excess. Annu rev med 1981; 32: 245-259.
17. Ryan MF. The role of magnesium in clinical biochemistry: an overview. Ann Clin Biochem 1991; 28: 19-20.
18. Sasaki S, Oshima T, Matsuura H, *et al*. Abnormal magnesium status in patients with cardiovascular diseases. Clin Sci (Colch). 2000;98:175-181.
19. Savory J, Margery KS, Shipe JR, *et al*. Stabilization of calmagite reagent automated measurement of magnesium in serum and urine. Clin Chem 1985; 31: 487-488.
20. Seelig MS. Magnesium interrelationships in ischemic heart disease. Am J Clin Nutr 1974; 27: 59-60.

Source of Support: None Declared
Conflict of Interest: None Declared